

What is claimed is:

1. A micro-actuator comprising  
a base plate on which a predetermined pattern of signal lines is formed;  
a plurality of fixed comb-type electrodes that are arranged on the base plate  
and extend in a direction perpendicular to the base plate;  
a stage capable of a see-saw motion that is arranged at a predetermined  
height from the top of the base plate;  
a plurality of driving comb-type electrodes which are formed parallel to each  
other on the bottom of the stage and whose ends extend between the fixed comb-  
type electrodes;  
a torsion bar with a predetermined length that is arranged at both ends of the  
stage forming one body with the stage in order to enable the see-saw motion of the  
stage;  
a first frame layer connected to both ends of the torsion bar;  
a second frame layer that is positioned below the first frame layer, thus  
forming a layered structure with the first frame layer; and  
a metal eutectic bonding layer formed between the first and second frame  
layers to bond them together.
2. The micro-actuator of claim 1, wherein the first frame layer, the torsion  
bar, the stage, and the driving comb-type electrodes form one body.
3. The micro-actuator of claim 1, wherein  
the first frame layer has a shape of a rectangular border that surrounds the  
stage;  
a separate region of a predetermined width is prepared between the first  
frame layer and the stage; and  
the torsion bar crosses the separate region.

1 4. The micro-actuator of claim 1, wherein  
2 the first frame layer has a shape of a rectangular border that surrounds the  
3 stage;  
4 a separate region of a predetermined width having a shape of rectangular  
5 border is prepared between the first frame layer and the stage; and  
6 the torsion bar crosses the separate region.

1 5. The micro-actuator of any of claims 1 - 4, wherein  
2 the fixed comb-type electrodes are formed on an electrode base that is  
3 arranged on the base plate, and  
4 the electrode base, the fixed comb-type electrodes and the second frame  
5 layer are formed of the same material plate.

1 6. The micro-actuator of claim 5, wherein the height of the fixed comb-  
2 type electrodes is greater than that of the second frame layer, and thus the front  
3 ends of the fixed comb-type electrodes are positioned higher than the top of the  
4 second frame layer.

1 7. The micro-actuator of any of claims 1 - 4, wherein the height of the  
2 fixed comb-type electrodes is greater than that of the second frame layer, and thus  
3 the front ends of the fixed comb-type electrodes are positioned higher than the top  
4 of the second frame layer.

1 8. The micro-actuator of any of claims 1 - 4, and 6, wherein  
2 the front ends of the driving comb-type electrodes and the first frame layer are on a  
3 common plane.

1 9. The micro-actuator of claim 5, wherein the front ends of the driving  
2 comb-type electrodes and the first frame layer are on a common plane.

1 10. The micro-actuator of any of claims 1 - 4, 6, and 9, wherein the metal  
2 eutectic bonding layer of the present invention is composed of a plurality of metal  
3 layers, among which the middle metal layer is plated with Au/Sn alloy.

1 11. A method for manufacturing a micro-actuator comprising the steps of:  
2 forming a top structure by etching both sides of a first plate, the top structure  
3 comprising a stage, a plurality of comb-type electrodes formed on the bottom of the  
4 stage, a torsion bar positioned in the middle of both edges facing the stage, and a  
5 first frame layer of a predetermined height supporting the torsion bar;  
6 forming a bottom structure by etching both sides of a second plate, the  
7 bottom structure comprising a base plate, a second frame layer formed on the base  
8 plate and having a predetermined height corresponding to the first frame layer  
9 height, and a plurality of fixed comb-type electrodes formed on the base plate; and  
10 joining the top and bottom structure to form one body by forming a eutectic  
11 bonding layer between the first frame layer and the second frame layer, and  
12 superimposing the driving and fixed comb-type electrodes such that the extensions  
13 of the driving comb-type electrodes alternate with the extensions of the fixed comb-  
14 type electrodes

1 12. The method for manufacturing a micro-actuator of claim 11, wherein  
2 the step of forming the top structure further comprises the steps of:  
3 forming a top separate region with a predetermined width and depth  
4 corresponding to the space between the stage and the first frame layer;  
5 forming a top metal layer on a region corresponding to the first frame layer;  
6 and

7 forming the driving comb-type electrodes with a predetermined height on the  
8 bottom of the stage, while the separate region is penetrated by etching the bottom of  
9 the first plate with a predetermined pattern.

1 13. The method for manufacturing a micro-actuator of claim 11, wherein  
2 the step of forming the bottom structure further comprise the steps of:

3 forming signal lines with a predetermined pattern corresponding to the  
4 constituent elements;

5 forming a bottom separate region with a predetermined width and depth  
6 corresponding to the space between the second frame layer and the fixed comb-  
7 type electrodes;

8 joining the bottom of the second plate to the top of the base plate;  
9 etching the region corresponding to the second frame layer to a  
10 predetermined depth on the top of the second plate;

11 forming a bottom metal layer on the etched part of the second plate;

12 forming a mask layer on the region corresponding to the second frame layer  
13 and the fixed comb-type electrodes on top of the second plate; and

14 forming the fixed comb-type electrodes with a predetermined height inside of  
15 the bottom separate region, while the bottom separate region is penetrated by  
16 etching to a predetermined depth the region that is not covered by the mask layer.

1 14. The method for manufacturing the micro-actuator of claim 12, wherein  
2 the step of forming the bottom structure further comprise the steps of:

3 forming signal lines with a predetermined pattern corresponding to the  
4 constituent elements;

5 forming a bottom separate region with a predetermined width and depth  
6 corresponding to the space between the second frame layer and the fixed comb-  
7 type electrodes;

8 joining the bottom of the second plate to the top of the base plate;

9 etching the region corresponding to the second frame layer to a  
10 predetermined depth on the top of the second plate;  
11 forming a bottom metal layer on the etched part of the second plate;  
12 forming a mask layer on the region corresponding to the second frame layer  
13 and the fixed comb-type electrode on top of the second plate; and  
14 forming the fixed comb-type electrode with a predetermined height inside of  
15 the bottom separate region, while the bottom separate region is penetrated by  
16 etching to a predetermined depth the region that is not covered by the mask layer.

1 15. The method for manufacturing a micro-actuator of claims 12 or 14,  
2 wherein the step of forming the top metal layer further comprises the steps of  
3 forming a metal seed layer on the bottom of the first plate; and  
4 forming a metal eutectic bonding layer by a plating method on the seed layer.

1 16. The method for manufacturing a micro-actuator of claim 15, wherein  
2 the step of joining the top and bottom structures into one body further comprises a  
3 step of performing the metal eutectic bonding at a predetermined temperature and  
4 pressure in order to join the first frame layer of the top structure to the second frame  
5 layer of the bottom structure, and more specifically to join the top metal layer of the  
6 first frame layer of the top structure to the bottom metal layer of the second frame  
7 layer of the bottom structure.

1 17. The method for manufacturing a micro-actuator of claims 13 or 14,  
2 wherein the step of forming a bottom metal layer on the second frame layer of the  
3 bottom structure further comprises a step of performing the metal eutectic bonding  
4 at a predetermined temperature and pressure in order to join the first frame layer of  
5 the top structure to the second frame layer of the bottom structure, and more  
6 specifically to join the top metal layer of the first frame layer of the top structure to  
7 the bottom metal layer of the second frame layer of the bottom structure.

1                   18.     The method for manufacturing a micro-actuator of any of claims 11-16,  
2     wherein the bottom of the second plate is joined to the top of the base plate by an  
3     anodic bonding process.

1                   19.     The method for manufacturing the micro-actuator of any of claims 17,  
2     wherein the bottom of the second plate is joined to the top of the base plate by an  
3     anodic bonding process.